

Application No. 10/674,376  
Amendment dated May 17, 2005  
Reply to Office Action of February 14, 2005

136299

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

**Listing of Claims:**

1. (canceled)
2. (Previously Presented) A light source comprising:  
a source of plasma discharge that emits electromagnetic ("EM") radiation, a portion of which has wavelengths shorter than about 200 nm; and  
a phosphor composition that comprises a plurality of particles, each of said particles comprising at least a first phosphor and at least a second phosphor, said phosphor composition is disposed such that said first phosphor absorbs substantially said portion of EM radiation having wavelengths shorter than about 200 nm, and said first phosphor emits EM radiation having wavelengths longer than about 200 nm, wherein said at least a first phosphor comprises a plurality of nanometer-sized particles disposed on a surface of a particle of said second phosphor.
3. (Previously Presented) A light source comprising:  
a source of plasma discharge that emits electromagnetic ("EM") radiation, a portion of which has wavelengths shorter than about 200 nm; and  
a phosphor composition that comprises a plurality of particles, each of said particles comprising at least a first phosphor and at least a second phosphor, said phosphor composition is disposed such that said first phosphor absorbs substantially said portion of EM radiation having wavelengths shorter than about 200 nm, and said first phosphor emits EM radiation having wavelengths longer than about 200 nm, wherein said at least a first phosphor forms a shell around each particle of said second phosphor.

Application No. 10/674,376

136299

Amendment dated May 17, 2005

Reply to Office Action of February 14, 2005

4. (original) The light source according to claim 2, wherein said source of plasma discharge is contained in a sealed housing.
5. (original) The light source according to claim 2, wherein said source of plasma comprises mercury gas, which produces a plasma discharge upon application of a voltage across the mercury gas.
6. (original) The light source according to claim 5, wherein said nanometer-sized particles of said at least a first phosphor have a size in a range from about 1 nm to about 500 nm.
7. (original) The light source according to claim 5, wherein said nanometer-sized particles of said at least a first phosphor have a size in a range from about 1 nm to about 200 nm.
8. (original) The light source according to claim 5, wherein said nanometer-sized particles of said at least a first phosphor have a size in a range from about 1 nm to about 100 nm.
9. (Previously Presented) The light source according to claim 5, wherein said particle of said at least a second phosphor have a size in a range from about 1 micrometer to about 6 micrometers.
10. (original) The light source according to claim 5; wherein said at least a first phosphor is selected from the group consisting of  $\text{LaPO}_4\text{:Pr}^{3+}$ ;  $\text{LaB}_3\text{O}_6\text{:Pr}^{3+}$ ;  $\text{LaBO}_3\text{:Pr}^{3+}$ ;  $\text{YBO}_3\text{:Pr}^{3+}$ ;  $\text{GdBO}_3\text{:Pr}^{3+}$ ;  $\text{LuBO}_3\text{:Pr}^{3+}$ ;  $(\text{Gd},\text{Y})\text{B}_3\text{O}_6\text{:Pr}^{3+}$ ;  $(\text{Sr},\text{Ca})\text{Al}_{12}\text{O}_{19}\text{:Pr}^{3+}$ ;  $(\text{La},\text{Gd},\text{Y})\text{MgB}_5\text{O}_{10}\text{:Pr}^{3+}$ ;  $\text{SrB}_4\text{O}_7\text{:Pr}^{3+}$ ;  $\text{CaMgAl}_{11.33}\text{O}_{19}\text{:Pr}^{3+}$ ;  $\text{CaMgAl}_{14}\text{O}_{23}\text{:Pr}^{3+}$ ;  $\text{YPO}_4\text{:Pr}^{3+}$ ;  $\text{GdPO}_4\text{:Pr}^{3+}$ ;  $\text{Y}_2\text{SiO}_5\text{:Pr}^{3+}$ ;  $\text{YPO}_4\text{:Bi}^{3+}$ ;  $\text{LuPO}_4\text{:Bi}^{3+}$ ;  $\text{LaPO}_4\text{:Pb}^{2+}$ ;  $\text{LaB}_3\text{O}_6\text{:Pb}^{2+}$ ;  $\text{LaBO}_3\text{:Pb}^{2+}$ ;  $\text{YBO}_3\text{:Pb}^{2+}$ ;  $\text{GdBO}_3\text{:Pb}^{2+}$ ;  $\text{LuBO}_3\text{:Pb}^{2+}$ ;  $(\text{Gd},\text{Y})\text{B}_3\text{O}_6\text{:Pb}^{2+}$ ;  $(\text{Sr},\text{Ca})\text{Al}_{12}\text{O}_{19}\text{:Pb}^{2+}$ ;  $(\text{La},\text{Gd},\text{Y})\text{MgB}_5\text{O}_{10}\text{:Pb}^{2+}$ ;  $\text{SrB}_4\text{O}_7\text{:Pb}^{2+}$ ;  $\text{CaMgAl}_{11.33}\text{O}_{19}\text{:Pb}^{2+}$ ;  $\text{CaMgAl}_{14}\text{O}_{23}\text{:Pb}^{2+}$ ;  $\text{YPO}_4\text{:Pb}^{2+}$ ;  $\text{GdPO}_4\text{:Pb}^{2+}$ ;  $\text{Y}_2\text{SiO}_5\text{:Pb}^{2+}$ ;  $\text{YPO}_4\text{:Pb}^{2+}$ ;  $\text{LuPO}_4\text{:Pb}^{2+}$ ;  $\text{LaPO}_4\text{:Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{LaB}_3\text{O}_6\text{:Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{LaBO}_3\text{:Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{YBO}_3\text{:Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{GdBO}_3\text{:Pr}^{3+},\text{Pb}^{2+}$ ;

Application No. 10/674,376  
 Amendment dated May 17, 2005  
 Reply to Office Action of February 14, 2005

136299

$\text{LuBO}_3:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  $(\text{Gd}, \text{Y})\text{B}_3\text{O}_6:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  $(\text{Sr}, \text{Ca})\text{Al}_{12}\text{O}_{19}:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  
 $(\text{La}, \text{Gd}, \text{Y})\text{MgB}_5\text{O}_{10}:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  $\text{SrB}_4\text{O}_7:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  $\text{CaMgAl}_{11.33}\text{O}_{19}:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  
 $\text{CaMgAl}_{14}\text{O}_{23}:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  $\text{YPO}_4:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  $\text{GdPO}_4:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  $\text{Y}_2\text{SiO}_5:\text{Pr}^{3+}, \text{Pb}^{2+}$ ;  
 $\text{YPO}_4:\text{Bi}^{3+}, \text{Pb}^{2+}$ ;  $\text{LuPO}_4:\text{Bi}^{3+}, \text{Pb}^{2+}$ ;  $\text{LaPO}_4:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $\text{LaB}_3\text{O}_6:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  
 $\text{LaBO}_3:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $\text{YBO}_3:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $\text{GdBO}_3:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  
 $\text{LuBO}_3:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $(\text{Gd}, \text{Y})\text{B}_3\text{O}_6:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $(\text{Sr}, \text{Ca})\text{Al}_{12}\text{O}_{19}:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  
 $(\text{La}, \text{Gd}, \text{Y})\text{MgB}_5\text{O}_{10}:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $\text{SrB}_4\text{O}_7:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  
 $\text{CaMgAl}_{11.33}\text{O}_{19}:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $\text{CaMgAl}_{14}\text{O}_{23}:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $\text{YPO}_4:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  
 $\text{GdPO}_4:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $\text{Y}_2\text{SiO}_5:\text{Pr}^{3+}, \text{Pb}^{2+}, \text{Bi}^{3+}$ ;  $\text{YPO}_4:\text{Pr}^{3+}, \text{Bi}^{3+}, \text{Pb}^{2+}$ ;  
 $\text{LuPO}_4:\text{Pr}^{3+}, \text{Bi}^{3+}, \text{Pb}^{2+}$ ;  $(\text{Ca}, \text{Mg}, \text{Sr})\text{SO}_4:\text{Pb}^{2+}$ ;  $\text{CaLi}_2\text{SiO}_4:\text{Pb}^{2+}$ ;  $(\text{Ca}, \text{Ba}, \text{Sr})\text{SiO}_3:\text{Pb}^{2+}$ ;  
 $\text{Ba}(\text{Y}, \text{Gd}, \text{Lu})\text{B}_9\text{O}_{16}:\text{Bi}^{3+}$ ;  $\text{YF}_3:\text{Bi}^{3+}$ ;  $\text{YOF}:\text{Bi}^{3+}$ ;  $(\text{Gd}, \text{Y})\text{OF}:\text{Bi}^{3+}, \text{Pr}^{3+}$ ;  $(\text{Y}, \text{Gd})_3\text{Al}_5\text{O}_{12}:\text{Bi}^{3+}$ ;  
 and combinations thereof.

11. (original) The light source according to claim 10, wherein said nanometer-sized particles of said first phosphor is produced by a method selected from the group consisting of flame spray pyrolysis, inverse-microemulsion, sol-gel, and colloidal suspension.

12. (original) The light source according to claim 5; wherein said at least a first phosphor is selected from the group consisting of  $\text{LaPO}_4:\text{Pr}^{3+}$ ;  $\text{LaB}_3\text{O}_6:\text{Pr}^{3+}$ ;  $\text{LaBO}_3:\text{Pr}^{3+}$ ;  
 $\text{YBO}_3:\text{Pr}^{3+}$ ;  $\text{GdBO}_3:\text{Pr}^{3+}$ ;  $\text{LuBO}_3:\text{Pr}^{3+}$ ;  $(\text{Gd}, \text{Y})\text{B}_3\text{O}_6:\text{Pr}^{3+}$ ;  $(\text{Sr}, \text{Ca})\text{Al}_{12}\text{O}_{19}:\text{Pr}^{3+}$ ;  
 $(\text{La}, \text{Gd}, \text{Y})\text{MgB}_5\text{O}_{10}:\text{Pr}^{3+}$ ;  $\text{SrB}_4\text{O}_7:\text{Pr}^{3+}$ ;  $\text{CaMgAl}_{11.33}\text{O}_{19}:\text{Pr}^{3+}$ ;  $\text{CaMgAl}_{14}\text{O}_{23}:\text{Pr}^{3+}$ ;  
 $\text{YPO}_4:\text{Pr}^{3+}$ ;  $\text{GdPO}_4:\text{Pr}^{3+}$ ;  $\text{Y}_2\text{SiO}_5:\text{Pr}^{3+}$ ;  $\text{YPO}_4:\text{Bi}^{3+}$ ;  $\text{LuPO}_4:\text{Bi}^{3+}$ ;  $(\text{Ca}, \text{Mg}, \text{Sr})\text{SO}_4:\text{Pb}^{2+}$ ;  
 $\text{CaLi}_2\text{SiO}_4:\text{Pb}^{2+}$ ;  $(\text{Ca}, \text{Ba}, \text{Sr})\text{SiO}_3:\text{Pb}^{2+}$ ;  $\text{Ba}(\text{Y}, \text{Gd}, \text{Lu})\text{B}_9\text{O}_{16}:\text{Bi}^{3+}$ ;  $\text{YF}_3:\text{Bi}^{3+}$ ;  $\text{YOF}:\text{Bi}^{3+}$ ;  
 $(\text{Gd}, \text{Y})\text{OF}:\text{Bi}^{3+}, \text{Pr}^{3+}$ ;  $(\text{Y}, \text{Gd})_3\text{Al}_5\text{O}_{12}:\text{Bi}^{3+}$ ; and combinations thereof.

13. (original) The light source according to claim 5, wherein said at least a second phosphor absorbs a portion of radiation emitted by said plasma discharge that has wavelengths longer than about 200 nm and radiation emitted by said at least a first phosphor, and said at least a second phosphor emits visible light.

Application No. 10/674,376

136299

Amendment dated May 17, 2005

Reply to Office Action of February 14, 2005

14. (original) The light source according to claim 13; wherein said at least a second phosphor is selected from the group consisting of  $\text{BaMg}_2\text{Al}_{16}\text{O}_{27}:\text{Eu}^{2+}$ ;  $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}$ ;  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})_5(\text{PO}_4)_3(\text{Cl},\text{F},\text{OH}):\text{Eu}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{BPO}_5:\text{Eu}^{2+}$ ;  $\text{Sr}_4\text{Al}_{14}\text{O}_{25}:\text{Eu}^{2+}$ ;  $\text{BaAl}_8\text{O}_{13}:\text{Eu}^{2+}$ ;  $2\text{SrO}\cdot 0.84\text{P}_2\text{O}_5\cdot 0.16\text{B}_2\text{O}_3:\text{Eu}^{2+}$ ;  $\text{MgWO}_4$ ;  $\text{BaTiP}_2\text{O}_8$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+},\text{Mn}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})_5(\text{PO}_4)_3(\text{Cl},\text{F},\text{OH}):\text{Sb}^{3+}$ ;  $\text{LaPO}_4:\text{Ce}^{3+},\text{Tb}^{3+}$ ;  $\text{GdMgB}_5\text{O}_{10}:\text{Ce}^{3+},\text{Tb}^{3+},\text{Mn}^{2+}$ ;  $\text{GdMgB}_5\text{O}_{10}:\text{Ce}^{3+},\text{Tb}^{3+}$ ;  $(\text{Tb},\text{Y},\text{Lu},\text{La},\text{Gd})_3(\text{Al},\text{Ga})_5\text{O}_{12}:\text{Ce}^{3+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})_5(\text{PO}_4)_3(\text{Cl},\text{F},\text{OH}):\text{Eu}^{2+},\text{Mn}^{2+},\text{Sb}^{3+}$ ;  $(\text{Y},\text{Gd},\text{La},\text{Lu},\text{Sc})_2\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Y},\text{Gd},\text{La},\text{In},\text{Lu},\text{Sc})\text{BO}_3:\text{Eu}^{3+}$ ;  $(\text{Y},\text{Gd},\text{La})(\text{Al},\text{Ga})\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})(\text{Y},\text{Gd},\text{La},\text{Lu})_2\text{O}_4:\text{Eu}^{3+}$ ;  $(\text{Y},\text{Gd})\text{Al}_3\text{B}_4\text{O}_{12}:\text{Eu}^{3+}$ ; monoclinic  $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Gd},\text{Y})_4(\text{Al},\text{Ga})_2\text{O}_9:\text{Eu}^{3+}$ ;  $(\text{Ca},\text{Sr})(\text{Gd},\text{Y})_3(\text{Ge},\text{Si})\text{Al}_3\text{O}_9:\text{Eu}^{3+}$ ;  $(\text{Sr},\text{Mg})_3(\text{PO}_4)_2:\text{Sn}^{2+}$ ;  $\text{GdMgB}_5\text{O}_{10}:\text{Ce}^{3+},\text{Mn}^{2+}$ ;  $3.5\text{MgO}\cdot 0.5\text{MgF}_2\cdot \text{GeO}_2:\text{Mn}^{4+}$ ; and combinations thereof.
15. (original) The light source according to claim 5, wherein said light source is selected from the group consisting of fluorescent lamps, compact fluorescent lamps, and electrodeless fluorescent lamps.
16. (original) A light source comprising:  
 a source of plasma discharge that emits EM radiation, a portion of which has wavelengths shorter than about 200 nm, said source of plasma discharge being contained in a sealed housing and comprising mercury gas, which produces said plasma discharge upon application of a voltage across said mercury gas; and  
 a phosphor composition that comprises a plurality of particles of at least a first phosphor and a plurality of particles of at least a second phosphor, wherein said particles of said at least a first phosphor have a nanometer size, each of particles of said at least a second phosphor is coated with particles of said at least a first phosphor, said phosphor composition is disposed such that said first phosphor absorbs substantially said portion of EM radiation having wavelengths shorter than about 200 nm, and said first phosphor emits EM radiation having wavelengths longer than about 200 nm;  
 wherein said particles of said at least a first phosphor have a size in a range from about 1

Application No. 10/674,378  
 Amendment dated May 17, 2005  
 Reply to Office Action of February 14, 2005

136299

nm to about 500 nm;

said particles of said at least a second phosphor have a size in a range from about 2 micrometers to about 6 micrometers;

said at least a first phosphor is selected from the group consisting of  $\text{LaPO}_4:\text{Pr}^{3+}$ ;  $\text{LaB}_3\text{O}_6:\text{Pr}^{3+}$ ;  $\text{LaBO}_3:\text{Pr}^{3+}$ ;  $\text{YBO}_3:\text{Pr}^{3+}$ ;  $\text{GdBO}_3:\text{Pr}^{3+}$ ;  $\text{LuBO}_3:\text{Pr}^{3+}$ ;  $(\text{Gd},\text{Y})\text{B}_3\text{O}_6:\text{Pr}^{3+}$ ;  $(\text{Sr},\text{Ca})\text{Al}_{12}\text{O}_{19}:\text{Pr}^{3+}$ ;  $(\text{La},\text{Gd},\text{Y})\text{MgB}_5\text{O}_{10}:\text{Pr}^{3+}$ ;  $\text{SrB}_4\text{O}_7:\text{Pr}^{3+}$ ;  $\text{CaMgAl}_{11.33}\text{O}_{19}:\text{Pr}^{3+}$ ;  $\text{CaMgAl}_{14}\text{O}_{23}:\text{Pr}^{3+}$ ;  $\text{YPO}_4:\text{Pr}^{3+}$ ;  $\text{GdPO}_4:\text{Pr}^{3+}$ ;  $\text{Y}_2\text{SiO}_5:\text{Pr}^{3+}$ ;  $\text{YPO}_4:\text{Bi}^{3+}$ ;  $\text{LuPO}_4:\text{Bi}^{3+}$ ;  $\text{LaPO}_4:\text{Pb}^{2+}$ ;  $\text{LaB}_3\text{O}_6:\text{Pb}^{2+}$ ;  $\text{LaBO}_3:\text{Pb}^{2+}$ ;  $\text{YBO}_3:\text{Pb}^{2+}$ ;  $\text{GdBO}_3:\text{Pb}^{2+}$ ;  $\text{LuBO}_3:\text{Pb}^{2+}$ ;  $(\text{Gd},\text{Y})\text{B}_3\text{O}_6:\text{Pb}^{2+}$ ;  $(\text{Sr},\text{Ca})\text{Al}_{12}\text{O}_{19}:\text{Pb}^{2+}$ ;  $(\text{La},\text{Gd},\text{Y})\text{MgB}_5\text{O}_{10}:\text{Pb}^{2+}$ ;  $\text{SrB}_4\text{O}_7:\text{Pb}^{2+}$ ;  $\text{CaMgAl}_{11.33}\text{O}_{19}:\text{Pb}^{2+}$ ;  $\text{CaMgAl}_{14}\text{O}_{23}:\text{Pb}^{2+}$ ;  $\text{YPO}_4:\text{Pb}^{2+}$ ;  $\text{GdPO}_4:\text{Pb}^{2+}$ ;  $\text{Y}_2\text{SiO}_5:\text{Pb}^{2+}$ ;  $\text{YPO}_4:\text{Pb}^{2+}$ ;  $\text{LuPO}_4:\text{Pb}^{2+}$ ;  $\text{LaPO}_4:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{LaB}_3\text{O}_6:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{LaBO}_3:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{YBO}_3:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{GdBO}_3:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{LuBO}_3:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $(\text{Gd},\text{Y})\text{B}_3\text{O}_6:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $(\text{Sr},\text{Ca})\text{Al}_{12}\text{O}_{19}:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $(\text{La},\text{Gd},\text{Y})\text{MgB}_5\text{O}_{10}:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{SrB}_4\text{O}_7:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{CaMgAl}_{11.33}\text{O}_{19}:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{CaMgAl}_{14}\text{O}_{23}:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{YPO}_4:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{GdPO}_4:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{Y}_2\text{SiO}_5:\text{Pr}^{3+},\text{Pb}^{2+}$ ;  $\text{YPO}_4:\text{Bi}^{3+},\text{Pb}^{2+}$ ;  $\text{LuPO}_4:\text{Bi}^{3+},\text{Pb}^{2+}$ ;  $\text{LaPO}_4:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{LaB}_3\text{O}_6:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{LaBO}_3:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{YBO}_3:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{GdBO}_3:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{LuBO}_3:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $(\text{Gd},\text{Y})\text{B}_3\text{O}_6:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $(\text{Sr},\text{Ca})\text{Al}_{12}\text{O}_{19}:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $(\text{La},\text{Gd},\text{Y})\text{MgB}_5\text{O}_{10}:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{SrB}_4\text{O}_7:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{CaMgAl}_{11.33}\text{O}_{19}:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{CaMgAl}_{14}\text{O}_{23}:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{YPO}_4:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{GdPO}_4:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{Y}_2\text{SiO}_5:\text{Pr}^{3+},\text{Pb}^{2+},\text{Bi}^{3+}$ ;  $\text{YPO}_4:\text{Pr}^{3+},\text{Bi}^{3+},\text{Pb}^{2+}$ ;  $\text{LuPO}_4:\text{Pr}^{3+},\text{Bi}^{3+},\text{Pb}^{2+}$ ;  $(\text{Ca},\text{Mg},\text{Sr})\text{SO}_4:\text{Pb}^{2+}$ ;  $\text{CaLi}_2\text{SiO}_4:\text{Pb}^{2+}$ ;  $(\text{Ca},\text{Ba},\text{Sr})\text{SiO}_3:\text{Pb}^{2+}$ ;  $\text{Ba}(\text{Y},\text{Gd},\text{Lu})\text{B}_9\text{O}_{16}:\text{Bi}^{3+}$ ;  $\text{YF}_3:\text{Bi}^{3+}$ ;  $\text{YOF}:\text{Bi}^{3+}$ ;  $(\text{Gd},\text{Y})\text{OF}:\text{Bi}^{3+},\text{Pr}^{3+}$ ;  $(\text{Y},\text{Gd})_3\text{Al}_5\text{O}_{12}:\text{Bi}^{3+}$ ; and combinations thereof; and

said at least a second phosphor emits visible light and is selected from the group consisting of  $\text{BaMg}_2\text{Al}_{16}\text{O}_{27}:\text{Eu}^{2+}$ ;  $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}$ ;  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})_5(\text{PO}_4)_3(\text{Cl},\text{F},\text{OH}):\text{Eu}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{BPO}_5:\text{Eu}^{2+}$ ;  $\text{Sr}_4\text{Al}_{14}\text{O}_{25}:\text{Eu}^{2+}$ ;  $\text{BaAl}_8\text{O}_{13}:\text{Eu}^{2+}$ ;  $2\text{SrO}\cdot 0.84\text{P}_2\text{O}_5\cdot 0.16\text{B}_2\text{O}_3:\text{Eu}^{2+}$ ;  $\text{MgWO}_4$ ;  $\text{BaTiP}_2\text{O}_8$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+},\text{Mn}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})_5(\text{PO}_4)_3(\text{Cl},\text{F},\text{OH}):\text{Sb}^{3+}$ ;  $\text{LaPO}_4:\text{Ce}^{3+},\text{Tb}^{3+}$ ;  $\text{GdMgB}_5\text{O}_{10}:\text{Ce}^{3+},\text{Tb}^{3+},\text{Mn}^{2+}$ ;  $\text{GdMgB}_5\text{O}_{10}:\text{Ce}^{3+},\text{Tb}^{3+}$ ;  $(\text{Tb},\text{Y},\text{Lu},\text{La},\text{Gd})_3$

Application No. 10/674,376  
 Amendment dated May 17, 2005  
 Reply to Office Action of February 14, 2005

136299

(Al,Ga)<sub>5</sub>O<sub>12</sub>:Ce<sup>3+</sup>; (Ba,Sr,Ca)<sub>5</sub>(PO<sub>4</sub>)<sub>3</sub>(Cl,F,OH):Eu<sup>2+</sup>, Mn<sup>2+</sup>, Sb<sup>3+</sup>;  
 (Y,Gd,La,Lu,Sc)<sub>2</sub>O<sub>3</sub>:Eu<sup>3+</sup>; (Y,Gd,La,In,Lu,Sc)BO<sub>3</sub>:Eu<sup>3+</sup>; (Y,Gd,La)(Al,Ga)O<sub>3</sub>:Eu<sup>3+</sup>;  
 (Ba,Sr,Ca)(Y,Gd,La,Lu)<sub>2</sub>O<sub>4</sub>:Eu<sup>3+</sup>; (Y,Gd)Al<sub>3</sub>B<sub>4</sub>O<sub>12</sub>:Eu<sup>3+</sup>; monoclinic Gd<sub>2</sub>O<sub>3</sub>:Eu<sup>3+</sup>;  
 (Gd,Y)<sub>4</sub>(Al,Ga)<sub>2</sub>O<sub>9</sub>:Eu<sup>3+</sup>; (Ca,Sr)(Gd,Y)<sub>3</sub>(Ge,Si)Al<sub>3</sub>O<sub>9</sub>:Eu<sup>3+</sup>; (Sr,Mg)<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>:Sn<sup>2+</sup>;  
 GdMgB<sub>5</sub>O<sub>10</sub>:Ce<sup>3+</sup>, Mn<sup>2+</sup>; 3.5MgO·0.5MgF<sub>2</sub>·GeO<sub>2</sub>:Mn<sup>4+</sup>; and combinations thereof.

17. (original) A light source comprising:

a source of plasma discharge that emits EM radiation, a portion of which has wavelengths shorter than about 200 nm, said source of plasma discharge being contained in a sealed housing and comprising mercury gas, which produces said plasma discharge upon application of a voltage across said mercury gas; and

a phosphor composition that comprises a plurality of particles of at least a first phosphor and a plurality of particles at least a second phosphor, wherein said particles of said at least a first phosphor have a nanometer size, each of particles of said at least a second phosphor is coated with particles of said at least a first phosphor, said phosphor composition is disposed such that said first phosphor absorbs substantially said portion of EM radiation having wavelengths shorter than about 200 nm, and said first phosphor emits EM radiation having wavelengths longer than about 200 nm;

wherein said particles of said at least a first phosphor have a size in a range from about 1 nm to about 500 nm;

said particles of said at least a second phosphor have a size in a range from about 2 micrometers to about 6 micrometers;

said at least a first phosphor is selected from the group consisting of LaPO<sub>4</sub>:Pr<sup>3+</sup>; LaB<sub>3</sub>O<sub>6</sub>:Pr<sup>3+</sup>; LaBO<sub>3</sub>:Pr<sup>3+</sup>; YBO<sub>3</sub>:Pr<sup>3+</sup>; GdBO<sub>3</sub>:Pr<sup>3+</sup>; LuBO<sub>3</sub>:Pr<sup>3+</sup>; (Gd,Y)B<sub>3</sub>O<sub>6</sub>:Pr<sup>3+</sup>; (Sr,Ca)Al<sub>12</sub>O<sub>19</sub>:Pr<sup>3+</sup>; (La,Gd,Y)MgB<sub>5</sub>O<sub>10</sub>:Pr<sup>3+</sup>; SrB<sub>4</sub>O<sub>7</sub>:Pr<sup>3+</sup>; CaMgAl<sub>11.33</sub>O<sub>19</sub>:Pr<sup>3+</sup>; CaMgAl<sub>14</sub>O<sub>23</sub>:Pr<sup>3+</sup>; YPO<sub>4</sub>:Pr<sup>3+</sup>; GdPO<sub>4</sub>:Pr<sup>3+</sup>; Y<sub>2</sub>SiO<sub>5</sub>:Pr<sup>3+</sup>; YPO<sub>4</sub>:Bi<sup>3+</sup>; LuPO<sub>4</sub>:Bi<sup>3+</sup>; (Ca,Mg,Sr)SO<sub>4</sub>:Pb<sup>2+</sup>; CaLi<sub>2</sub>SiO<sub>4</sub>:Pb<sup>2+</sup>; (Ca,Ba,Sr)SiO<sub>3</sub>:Pb<sup>2+</sup>; Ba(Y,Gd,Lu)B<sub>9</sub>O<sub>16</sub>:Bi<sup>3+</sup>; YF<sub>3</sub>:Bi<sup>3+</sup>; YOF:Bi<sup>3+</sup>; (Gd,Y)OF:Bi<sup>3+</sup>, Pr<sup>3+</sup>; (Y,Gd)<sub>3</sub>Al<sub>5</sub>O<sub>12</sub>:Bi<sup>3+</sup>; and combinations thereof; and

Application No. 10/674,376  
 Amendment dated May 17, 2005  
 Reply to Office Action of February 14, 2005

136299

said at least a second phosphor emits visible light and is selected from the group consisting of  $\text{BaMg}_2\text{Al}_{16}\text{O}_{27}:\text{Eu}^{2+}$ ;  $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}$ ;  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})_5(\text{PO}_4)_3(\text{Cl},\text{F},\text{OH}):\text{Eu}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{BPO}_5:\text{Eu}^{2+}$ ;  $\text{Sr}_4\text{Al}_{14}\text{O}_{25}:\text{Eu}^{2+}$ ;  $\text{BaAl}_8\text{O}_{13}:\text{Eu}^{2+}$ ;  $2\text{SrO}\cdot 0.84\text{P}_2\text{O}_5\cdot 0.16\text{B}_2\text{O}_3:\text{Eu}^{2+}$ ;  $\text{MgWO}_4$ ;  $\text{BaTiP}_2\text{O}_8$ ;  $(\text{Ba},\text{Sr},\text{Ca})\text{MgAl}_{10}\text{O}_{17}:\text{Eu}^{2+},\text{Mn}^{2+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})_5(\text{PO}_4)_3(\text{Cl},\text{F},\text{OH}):\text{Sb}^{3+}$ ;  $\text{LaPO}_4:\text{Ce}^{3+},\text{Tb}^{3+}$ ;  $\text{GdMgB}_5\text{O}_{10}:\text{Ce}^{3+},\text{Tb}^{3+},\text{Mn}^{2+}$ ;  $\text{GdMgB}_5\text{O}_{10}:\text{Ce}^{3+},\text{Tb}^{3+}$ ;  $(\text{Tb},\text{Y},\text{Lu},\text{La},\text{Gd})_3(\text{Al},\text{Ga})_5\text{O}_{12}:\text{Ce}^{3+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})_5(\text{PO}_4)_3(\text{Cl},\text{F},\text{OH}):\text{Eu}^{2+},\text{Mn}^{2+},\text{Sb}^{3+}$ ;  $(\text{Y},\text{Gd},\text{La},\text{Lu},\text{Sc})_2\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Y},\text{Gd},\text{La},\text{In},\text{Lu},\text{Sc})\text{BO}_3:\text{Eu}^{3+}$ ;  $(\text{Y},\text{Gd},\text{La})(\text{Al},\text{Ga})\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Ba},\text{Sr},\text{Ca})(\text{Y},\text{Gd},\text{La},\text{Lu})_2\text{O}_4:\text{Eu}^{3+}$ ;  $(\text{Y},\text{Gd})\text{Al}_3\text{B}_4\text{O}_{12}:\text{Eu}^{3+}$ ; monoclinic  $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$ ;  $(\text{Gd},\text{Y})_4(\text{Al},\text{Ga})_2\text{O}_9:\text{Eu}^{3+}$ ;  $(\text{Ca},\text{Sr})(\text{Gd},\text{Y})_3(\text{Ge},\text{Si})\text{Al}_3\text{O}_9:\text{Eu}^{3+}$ ;  $(\text{Sr},\text{Mg})_3(\text{PO}_4)_2:\text{Sn}^{2+}$ ;  $\text{GdMgB}_5\text{O}_{10}:\text{Ce}^{3+},\text{Mn}^{2+}$ ;  $3.5\text{MgO}\cdot 0.5\text{MgF}_2\cdot \text{GeO}_2:\text{Mn}^{4+}$ ; and combinations thereof.

18. (original) A method for making a light source, said method comprising:

providing a source of plasma discharge that emits EM radiation, a portion of which has wavelengths shorter than about 200 nm;

containing said source of plasma discharge in a sealed housing; and

disposing a phosphor composition in said sealed housing, which phosphor composition comprises a plurality of particles, each of said particle comprising at least a first phosphor and at least a second phosphor, said at least a first phosphor being disposed on each particle of said second phosphor, and said phosphor composition being disposed such that said first phosphor absorbs substantially said portion of EM radiation having wavelengths shorter than about 200 nm, and said first phosphor emitting EM radiation having wavelengths longer than about 200 nm.

19. (original) The method according to claim 18, wherein said source of plasma discharge comprises mercury gas, which produces a plasma discharge upon application of a voltage across said mercury gas.

20. (Previously Presented) The method according to claim 19, wherein said providing said plasma source comprises providing an amount of mercury sufficient to maintain a mercury vapor pressure of about 0.8 Pa at a temperature of about 40°C.

Application No. 10/674,376  
Amendment dated May 17, 2005  
Reply to Office Action of February 14, 2005

136299

21. (original) A method for making a light source, said method comprising:  
providing an envelope made of a material, that is substantially transparent;  
depositing a layer of a phosphor composition on an inner surface of said envelope,  
said phosphor composition comprising a plurality of particles, each of said particles  
comprising at least a first phosphor and at least a second phosphor, said at least a first  
phosphor forming a coating around each of particles of said at least a second phosphor;  
evacuating said envelope to provide an evacuated envelope having said layer of  
said phosphor composition thereon;  
adding a first amount of mercury and a second amount of an inert gas into said  
evacuated envelope;  
providing a means for generating a plasma discharge from said mercury and said  
inert gas; and  
sealing said envelope to produce said light source.
22. (original) The method according to claim 21, wherein said forming a coating  
comprises depositing a plurality of nanometer-sized particles of said first phosphor  
around each particle of said second phosphor.
23. (Previously Presented) The method according to claim 22, wherein said first  
amount of mercury is sufficient to maintain a mercury vapor pressure of about 0.8 Pa at a  
temperature of about 40°C.
24. (canceled)
25. (Previously Presented) A phosphor composition comprising a plurality of  
particles, each of said particles comprising at least a first phosphor and at least a second  
phosphor, said first phosphor being capable of absorbing EM radiation having  
wavelengths shorter than about 200 nm, and being capable of emitting EM radiation  
having wavelengths longer than about 200 nm, wherein said first phosphor comprises a  
plurality of nanometer-sized particles, which are disposed around a particle of said second  
phosphor.
26. (Previously Presented) A phosphor composition comprising a plurality of  
particles, each of said particles comprising at least a first phosphor and at least a second



Application No. 10/674,376

136299

Amendment dated May 17, 2005

Reply to Office Action of February 14, 2005

phosphor, said first phosphor being capable of absorbing EM radiation having wavelengths shorter than about 200 nm, and being capable of emitting EM radiation having wavelengths longer than about 200 nm, wherein said first phosphor comprises a shell around a particle of said second phosphor.